

# Babu Banarasi Das University, Lucknow

## Department of Civil Engineering

### School of Engineering

#### Master of Technology (Hydraulics & Water Resources Engineering) - Regular

#### Evaluation Scheme (w.e.f Session 2021-22)

<b>SEMESTER I</b>									
<b>Course Category</b>	<b>Course Code</b>	<b>Code Title</b>	<b>Contact Hours</b>			<b>Evaluation Scheme</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	<b>CI A</b>	<b>ES E</b>	<b>Course Total</b>	
<b>C</b>	MAS4106	Applied Mathematics	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4101	Advanced Ground Water Hydrology	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4102	Advanced Hydrology	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4103	Free Surface Flow	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>GE</b>	GE4(UB)11/ GE4(UB)15	Generic Elective I	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4151	Hydraulic Engineering Lab	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>C</b>	MWE4152	Seminar	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>C</b>	MWE4153	Technical Paper Writing	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>Total</b>			<b>20</b>	<b>0</b>	<b>6</b>	<b>500</b>	<b>300</b>	<b>800</b>	<b>23</b>

#### Legends:

- L** Number of Lecture Hours per week  
**T** Number of Tutorial Hours per week  
**P** Number of Practical Hours per week  
**CIA** Continuous Internal Assessment  
**ESE** End Semester Examination

#### Category of Courses:

- C** Core Course  
**GE** Generic Elective

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<b>SEMESTER II</b>									
<b>Course Category</b>	<b>Course Code</b>	<b>Code Title</b>	<b>Contact Hours</b>			<b>Evaluation Scheme</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	<b>CIA</b>	<b>ESE</b>	<b>Course Total</b>	
<b>C</b>	MWE4201	Advanced Irrigation Engineering	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4202	Advanced Hydraulic Structures	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4203	Numerical Methods in Flood Routing	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4204	Water Resources Management	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>GE</b>	GE4(UB)21/ GE4(UB)25	Generic Elective II	4	0	0	40	60	<b>100</b>	<b>4</b>
<b>C</b>	MWE4251	Water Analysis and Hydrology Laboratory	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>C</b>	MWE4252	Seminar	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>C</b>	MWE4253	Technical Paper Presentation	0	0	2	100	0	<b>100</b>	<b>1</b>
<b>Total</b>			<b>20</b>	<b>0</b>	<b>6</b>	<b>500</b>	<b>300</b>	<b>800</b>	<b>23</b>

**Legends:**

- L**     Number of Lecture Hours per week
- T**     Number of Tutorial Hours per week
- P**     Number of Practical Hours per week
- CIA**   Continuous Internal Assessment
- ESE**   End Semester Examination

**Category of Courses:**

- C**     Core Course
- GE**    Generic Elective

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<b>SEMESTER III</b>									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CI A	ES E	Course Total	
C	MWE4351	State of the art Seminar#	-	-	-	200	0	<b>200</b>	<b>4</b>
C	MWE4352	Thesis - I*	-	-	-	400	0	<b>400</b>	<b>16</b>
<b>Total</b>			-	-	-	<b>600</b>	<b>0</b>	<b>600</b>	<b>20</b>

# Student need to perform a literature survey and will give a state of the art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for thesis.

\* Student will develop the workable model for the problem they have supposed in synopsis.

<b>SEMESTER IV</b>									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CI A	ES E	Course Total	
C	MWE4451	Thesis - II**	-	-	-	200	800	<b>1000</b>	<b>28</b>
<b>Total</b>			-	-	-	<b>200</b>	<b>800</b>	<b>1000</b>	<b>28</b>

\*\* (a) This is in continuation with Thesis - I.

(b) The required experimental / mathematical verification of the proposed model will be done in this semester.

#### Legends:

**L** Number of Lecture Hours per week

**T** Number of Tutorial Hours per week

**P** Number of Practical Hours per week

**CIA** Continuous Internal Assessment

**ESE** End Semester Examination

#### Category of Courses:

**C** Core Course

**GE** Generic Elective

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<b>Course Code</b>	<b>Generic Elective-I</b>
GE4(UB)11	River Engineering
GE4(UB)12	Irrigation and Drainage Systems Engineering
GE4(UB)13	Hydro Power Structures
GE4(UB)14	Computational Fluid Dynamics
GE4(UB)15	Socio-Economic and Environmental Evaluation of Water Resources Projects

<b>Course Code</b>	<b>Generic Elective-II</b>
GE4(UB)21	Water Supply Distribution Systems
GE4(UB)22	Environmental Aspects of Water Resources
GE4(UB)23	Computational Techniques in Water Resources Engineering
GE4(UB)24	Remote Sensing Applications in Water Resources Engineering
GE4(UB)25	Finite Element Analysis

Note – UB code will be allotted by the University as and when required.

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Credit Summary Chart						
Course Category	Semester				Total Credits	%age
	I	II	III	IV		
C	19	19	20	28	86	91.48
GE	4	4			8	8.52
<b>Total</b>	<b>23</b>	<b>23</b>	<b>20</b>	<b>28</b>	<b>94</b>	<b>100</b>

Discipline wise Credit Summary Chart						
Course Category	Semester				Total Credits	%age
	I	II	III	IV		
Engineering Sciences	4				4	4.26
Professional Subject Core	13	17			30	31.92
Professional Subject - General Elective	4	4			8	8.52
Thesis, Seminar	2	2	20	28	52	55.32
<b>Total</b>	<b>23</b>	<b>23</b>	<b>20</b>	<b>28</b>	<b>94</b>	<b>100</b>

#### Legends:

- L** Number of Lecture Hours per week
- T** Number of Tutorial Hours per week
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- CIA** Continuous Internal Assessment
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#### Category of Courses:

- C** Core Course
- GE** Generic Elective

## **MWE4101 ADVANCED GROUND WATER HYDROLOGY**

### **Course Objective:**

1. To know about the groundwater and its related problems.
2. To know about the basics of flow equation and pollutant transport.
3. To know about the basics of Sea Water Intrusion.
4. To know about the basics of problems in ground water development and management.

### **Learning Outcome:**

1. Illustrate about the groundwater and its related problems.
2. Exposure on flow equation and pollutant transport.
3. Exposure on Sea Water Intrusion.
4. Illustrate the basics of problems in ground water development and management.

### **Course Contents:**

<b>Module</b>	<b>Course Topics</b>	<b>Total Hours</b>	<b>Credits</b>
<b>I</b>	<b>Introduction to groundwater</b> Groundwater as a resource, general problems of chemical contamination in groundwater; Fluid potential, heterogeneity and anisotropy, Aquifers, aquitard sand general geology, well hydraulics, and parameter estimation.	30 Hours	1
<b>II</b>	<b>Governing Equation</b> Steady and transient flow equations, unsaturated flow equation. <b>Pollutant transport</b> Pollutant transport in ground water, chemical and transport processes, numerical modeling and solution, break through curves.	30 Hours	1
<b>III</b>	<b>Sea Water Intrusion</b> Seawater intrusion in coastal aquifers, Modeling of pollutant transport in the unsaturated zone, Optimization models for management of ground water quantity and quality, Optimal monitoring network design, Multiple objective management.	30 Hours	1
<b>IV</b>	Special topics: Special problems in ground water development and management artificial recharge.	30 Hours	1

**References:**

1. Todd D. K., "Ground Water Hydrology", Wiley India Pvt Ltd.
2. Bouwer H., "[Groundwater Hydrology](#)", Tata Mc Graw Hill.
3. Nagabhushaniah, "[Ground water in Hydrosphere: Groundwater Hydrology](#)", CBS Publisher.
4. [Chahar](#), "Groundwater Hydrology", McGraw Hill Education.

## MWE4102 ADVANCED HYDROLOGY

### Course Objective:

1. To know about the basics of hydrological processes.
2. To know about the basics of Hydrologic measurements and networks analysis.
3. To know about the Time Series Analysis.
4. To know about the basics of Statistical Methods.

### Learning Outcome:

1. Exposure on hydrological processes.
2. Exposure on Hydrologic measurements and networks analysis.
3. Illustrate about the Time Series Analysis.
4. Exposure on Statistical Methods.

### Course Contents:

Module	Course Topics	Total Hours	Credits
<b>I</b>	<p><b>Hydrological processes</b> The hydrologic processes: precipitation, evaporation, infiltration, groundwater, and stream flow. India's Water Resources, Water budget equation, Introduction to Modern Techniques for hydrology study. Remote sensing - Geographical Information System (GIS). Explain hydro meteorological parameter</p>	30 Hours	1
<b>II</b>	<p>Definition and Describe Causes of flood, Factors affecting flood, Classify floods, Explain Flood Estimation methods -Estimating the observed flood &amp; increasing it by certain percentage -Envelope curves method - Empirical formulae - Unit Hydrograph method - Flood frequency method - Gumbel's method Methods of flood control, Flood mitigation measures, Flood damage analysis, Flood preparedness, Relief and recovery, Flood plain zoning and flood losses.</p> <p><b>Hydrological Measurements</b> Hydrologic measurements and networks analysis of discrete and continuous hydrologic data: harmonic analysis, statistical analysis including frequency analysis, correlation, and regression analysis and multivariate analysis.</p>	30 Hours	1
<b>III</b>	<p><b>Time Series Analysis</b> Time series analysis and its application: system analysis and synthesis, linear and nonlinear, lumped</p>	30 Hours	1



	and distributed parameter systems, simulation analysis.		
<b>IV</b>	<b>Statistical Methods</b> Statistical methods in hydrology, probability distribution of hydrologic variables, hypothesis testing and goodness of fit, flood frequency analysis, single and multiple regression analysis, classification of time series, characteristics of hydrologic time series, statistical principles and techniques for hydrologic time series modeling, time series modeling of annual and periodic hydrologic time series (including AR, ARMA, ARIMA, and DARMA models),	30 Hours	1

**References:**

1. Subramanya K., "Engineering Hydrology", McGraw Hill Education.
2. Garg, S.K., "[Hydrology and Water Resources Engineering](#)", Khanna Publication.
3. Patra, K C, "[Hydrology and Water Resources Engineering](#)", Narosa Book Distributors Pvt Ltd-New Delhi.
4. [Ven Chow](#), [Larry Mays](#), [David Maidment](#), "Applied Hydrology", McGraw Hill Education.

## MWE4103 FREE SURFACE FLOW

### Course Objective:

1. To know about the basics of free surface flow.
2. To know about the gradually and rapid varied flow.
3. To know about the basics of unsteady open channel flow.
4. To know about the basics of spatially varied flow.

### Learning Outcome:

1. Exposure on free surface flow.
2. Illustrate about the gradually and rapid varied flow.
3. Illustrate about the basics of unsteady open channel flow.
4. Illustrate about the basics of spatially varied flow.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Basic Principles</b> Review of free surface flow concepts including velocity and pressure distribution, Continuity, Momentum and Energy equation, concept of specific energy, computation of critical flow, channel transitions, critical flow venturi-flume, standing wave flume and broad crested weir in discharge measurement.	30 Hours	1
II	<b>Gradually Varied Flow</b> Gradually varied profile and its computations using direct step method, advanced numerical methods, delivery of canal systems. Flow Profiles Rapid Varied Flow: Hydraulic jump in horizontal and sloped open channel bed and its characteristics Hydraulic jump as energy dissipators, Crested weirs, ogee spillway; Culvert hydraulics; Sluice gate flow	30 Hours	1
III	<b>Unsteady open channel flow</b> Wave celerity, classification of water waves according to relative depth, orbital motions, superposition, wave trains and wave energy, transformation of waves, dissipation of wave energy, positive and negative surges in rectangular channel, Momentum and Continuity equations (Saint Venant Equation)	30 Hours	1
IV	<b>Spatially varied flow</b> Spatially varied flow with increasing and decreasing discharge, Basic principles and assumptions, dynamic equation and analysis of flow profiles, Numerical	30 Hours	1

	integration method, Isoclinal method, spatially varied steady and unsteady surface flows.		
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**References:**

1. Chaudhary Hanif M., "Open Channel flow", Prantice-Hall of India Pvt. Ltd. New Delhi.
2. Chow V T, "Open Channel Hydraulics", McGraw-Hill Book Company, International editions, New Delhi.
3. Subrmanya K, "Flow in open channels", Second edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Srivastava Rajesh, "Flow through open channels", Oxford University press, New Delhi.
5. French R H, "Open channel hydraulics", McGraw Hill Publication, New York.  
Ranga Raju K.G., "Flow through Open Channels", Tata McGraw-Hill Publishing Company Limited.

## **MWE4151 HYDRAULIC ENGINEERING LAB**

### **List of Experiments**

- 1.** Measurement of velocity distribution in open channel using Pitot tube, current meter and ADV, plotting of isovels and computation of  $\alpha$  and  $\beta$ .
- 2.** Establishment of subcritical, critical and supercritical flows in open channel, plotting of specific energy diagram.
- 3.** To determine the characteristics of hydraulic jump in open channel.
- 4.** Measurement and computation of Gradually Varied flow profiles in open channel.
- 5.** Measurement of development of boundary layer thickness on flat plate.
- 6.** Measurement of drag and lift force coefficient for cylinder and spheres
- 7.** Measurements of bed shear stress by Preston tube.

## MWE4201 ADVANCED IRRIGATION ENGINEERING

### Course Objective:

1. To know about the basics of Sources of irrigation.
2. To know about the Irrigation Methods.
3. To know about the Rain Water Harvesting.

### Learning Outcome:

1. Illustrate about the basics of sources of irrigation.
2. Illustrate about the Irrigation Methods.
3. Exposure on Rain Water Harvesting.
4. Exposure on Social Contribution with case studies.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Sources of irrigation, Water resources of India, Surface water and Ground Water, Irrigation practice in India, multipurpose reservoirs, large irrigation systems in India, Impact of irrigation on water resources, Conjunctive management of surface and groundwater.	30 Hours	1
II	Advanced Irrigation Methods: Sprinkler irrigation: Design, advantages and disadvantages, Drip irrigation: Design, advantages and disadvantages. Design of Irrigation Channel: Kennedy's silt theory-Lacey's regime theory	30 Hours	1
III	Rain Water Harvesting: Rain water harvesting: Different methods, Case study on nearby irrigation system. Diversion head works Cross drainage works Canal regulation works	30 Hours	1
IV	Social Contribution: Society participation in canal system management. Case Studies: IGNP and Narmada Canal system.	30 Hours	1

### References:

1. Garg S. K., "Irrigation Engineering and Hydraulic structures", Khanna Publishers.
2. Asawa G. L., "Irrigation and Water Resources Engineering", New Age International Publishers.

## MWE4202 ADVANCED HYDRAULIC STRUCTURES

### Course Objective:

1. To know about the Water Resources Engineering Project and basics of Gravity Dam.
2. To know the basics of Embankment Dam.
3. To know the basics of Spillways and Energy Dissipaters.
4. To know about the basics of Diversion Headwork's.

### Learning Outcome:

1. Illustrate about the Water Resources Engineering Project and Gravity Dam.
2. Illustrate about the Embankment Dam.
3. Illustrate about Spillways and Energy Dissipaters.
4. Illustrate about Diversion Headwork's.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Planning of Water Resources Engineering Project</b> Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments. Gravity Dam: Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams, dam safety and hazard mitigation.	30Hours	1
II	<b>Embankment Dam</b> Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body and dam foundation, classification of rock fill dams and their design considerations.	30 Hours	1
III	<b>Spillways and Energy Dissipaters</b> Capacity of spillways, components and profile of different types of spillways, Non-conventional type of spillways, selection and design of energy dissipaters.	30 Hours	1
IV	Diversion Headwork's Components of diversion head works and their functions, design of weirs and barrages on permeable foundations. Canal Structures, Canal regulation structures and design of cross drainage works, canal drops, operation and maintenance of canals.	30 Hours	1

**References:**

1. USBR, Design of gravity dams, A Water Resources Technical Publication, Denver, Colorado.
2. USBR, Design of small dams, A water resources technical publication, Oxford and IBH publishing co., New Delhi.
3. Creager W P, Justin J D and Hinds J., “Engineering for dams”, Nem chand and Brothers, Roorkee.
4. Khatsuria R M, “Hydraulics of spillways and energy dissipaters”, CRC Press.
5. Novak P, “Hydraulic Structures”, Taylor and Francis Group publishers.

## MWE4203 NUMERICAL METHODS IN FLOOD ROUTING

### Course Objective:

1. To know the basics of Flow equations.
2. To know about the numerical methods in flood routing.
3. To know about the flow analysis.
4. To know about the sediment routing

### Learning Outcome:

1. Illustrate the basics of Flow equations.
2. Illustrate the numerical methods in flood routing.
3. Illustrate the flow analysis.
4. Illustrate the sediment routing.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Basic Equations: Review of basic equations; 2D Shallow water flow equations: Boussinesq equations, Saint Venant equation.	30 Hours	1
II	Method of Solution: Method of Characteristics, Finite-difference solutions: explicit and implicit methods, Stability Criteria.	30 Hours	1
III	Problems: Dam break flow analysis, Flood routing, super critical flow.	30 Hours	1
IV	Sediment Routing: Sediment routing models coupled and decoupled models, Stability criteria.	30 Hours	1

### References:

1. Choudhary Hanif M., "Open Channel flow", Springer.
2. [Das Madan Mohan](#), "Open Channel Flow", PHI Learning Private Limited.
3. Reddy Rami Jaya P., "A textbook of Hydrology", Laxmi Publication.



## **MWE4204 Water Resources Engineering**

### **Course Objective:**

1. To know about the basics of Water resources system.
2. To know about the basics of Economics of Water Resources system.
3. To know about the basics of Multipurpose Water Resources and its Optimization.
4. To know about the basics Water Resources Planning and its application.

### **Learning Outcome:**

1. Exposure on basics of Water resources system.
2. Exposure on basics of Economics of Water Resources system.
3. Exposure on basics of Multipurpose Water Resources and its Optimization.
4. Exposure on basics Water Resources Planning and its application.

### **Course Contents:**

<b>Module</b>	<b>Course Topics</b>	<b>Total Hours</b>	<b>Credits</b>
<b>I</b>	Introduction: Water resources system, components of the system, objectives of water resources development, development, planning, and construction and operation of water resources systems, System demands, geographic and geological aspects, economic, social and political consideration in system development. Principles of watershed management, soil and water conservation practices.	30 Hours	1
<b>II</b>	Principles of economic planning and decision making, price theory and resource allocation, Project Optimality conditions, cost- benefit studies: role of benefit-cost parameter in project selection. Economic feasibility tests. Involvement of risk and other variables, tangible and intangible benefits; Cost-benefit studies of single and multipurpose water resources projects.	30 Hours	1
<b>III</b>	Multipurpose Water Resources: Planning for multipurpose water resource projects, Benefits and costs. Optimization: Introduction to mathematical optimization techniques; Multi-objective optimization; Application of optimization techniques.	30 Hours	1
<b>IV</b>	Water Resources Planning: Water resources planning under uncertainty; Stochastic planning models; Application of simulation models.	30 Hours	1

## References:

1. Asawa G. L., "Irrigation and Water Resources Engineering", New Age International Publishers.
2. [Punmia](#) B. C., "Irrigation and Water Power Engineering", Laxmi Publication.
3. Garg S.K., "Irrigation Engineering and Hydraulic Structures", Khanna Publisher.
4. [Basak N. N.](#), "Irrigation Engineering", McGraw Hill Education.
5. [Arora](#) K R, "Irrigation Water Power and Water Resource Engineering", Standard Publishers Distributors.
6. [Modi](#) P. N., "Irrigation Water Resources and Water Power Engineering", Standard Publishers Distributors.
7. [Raghunath](#) H. M., "Irrigation Engineering", Wiley India Pvt Ltd.

## **MWE4251 WATER ANALYSIS AND HYDROLOGY LABORATORY**

### **List of Experiments**

- 1.** Rainfall Data collection by Natural Syphon Recording type Rain gauge and determination of mass curve and hyetograph from the obtained chart.
- 2.** Determination of infiltration rate by Double Ring type Infiltrometer.
- 3.** Determination of Coefficient of Permeability of Soil using Drain Permeator.
- 4.** Determination of rate of evaporation through Pan Evaporimeter.
- 5.** To find Rainfall and Runoff characteristics using Rainfall Simulator.
- 6.** To study infiltration capacity of different type of soil by Infiltrometer.
- 7.** Hydrograph Analysis.

## GE4 (UB) 11 RIVER ENGINEERING

### Course Objective:

1. To know about the classification of river and sedimentation.
2. To know about the sediment load and geomorphic cycle.
3. To know about the basics of River Training Works.

### Learning Outcome:

1. Exposure on classification of river and sedimentation.
2. Exposure on sediment load and geomorphic cycle.
3. Illustrate about the basics of River Training Works.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Introduction</b> River classifications, Sediment properties, incipient motion, Significance, bed forms in alluvial streams and their prediction, Resistance to flow in alluvial streams.	30 Hours	1
II	<b>Sediment load</b> Transport of sediment load, estimation of bed load, suspended load and total load, Aggradation and degradation, Local scour, Hydraulic geometry of alluvial streams, cross section, longitudinal profile and plan forms, meandering of rivers, geomorphic cycle.	30 Hours	
III	<b>River Training Works</b> Type of river training works, guide bunds, Groynes, levees, cutoff, pitched island, temporary spurs, stabilization of rivers.	30 Hours	1
IV	<b>River models</b> Choice of scale for different entities, distorted models, distortion of scale, simulation of sediment transport and the geometry.	30 Hours	1

### References:

1. Varma C.V.J. Saxena, K. R. and Rao, M. K., "River behavior management and training (Vol. I and II)", CBI&P, New Dehli
2. Punmia B. C., and Lal B. B., "Irrigation & Water Power Engineering", Laxmi Pub.
3. Yang, C.T., "Sediment transport theory and Practice", McGraw-Hill, New York.

4. Graf, W.H., "Hydraulics of sediment transport", McGraw-Hill, New York.
5. Henderson F.M., "Open Channel Flow", MacMillan, New York.
6. Chang H.H., "Fluvial Processes in River Engineering", John Wiley.
7. Garde, R.J. and Ranga Raju, K.G., "Mechanics of Sediment Transport and Alluvial Stream Problems", New Age International (P) Ltd. Publications, New Delhi.
8. Jansen, P. Ph, Van Bendegon L., De vries, M., "Principles of River Engineering", Pitman, London.
9. Garde, R.J., "History of Fluvial Hydraulics", New Age International (P) Ltd. Publishers, New Delhi.
10. Garde, R.J., "River Morphology", New Age International (P) Ltd. Publishers, New Delhi.

## GE4 (UB) 12 IRRIGATION AND DRAINAGE SYSTEMS ENGINEERING

### Course Objective:

1. To know about the basics of irrigation and national water policy.
2. To know about the Soil Water Crop Relationship.
3. To know about the basics of Modeling of Irrigation Systems.

### Learning Outcome:

1. Illustrate about the basics of irrigation and national water policy.
2. Illustrate about the soil water crop relationship.
3. Exposure on modeling of irrigation systems.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Introduction</b> Available water resources and its present utilization, Development through five year plans, Roles of various commissions on irrigation and agriculture, National water policy for development, Types of irrigation, Irrigation techniques and quality of irrigation water.	30 Hours	1
II	<b>Soil Water Crop Relationship</b> Determination of soil moisture, estimation of consumptive use and frequency of irrigation, irrigation efficiencies for economical use of water, design of various irrigation methods, assessment water charges, conjunctive use of surface and ground water, multi-crop irrigation scheduling. Soil salinity and water quality	30 Hours	1
III	<b>Modeling of Irrigation Systems</b> Governing equations and their solutions, computation of inundation front, cumulative infiltration estimation, modeling for sprinklers and other methods of irrigation.	30 Hours	1
IV	<b>Drainage of irrigated soils</b> Need and purpose of drainage, water logging of agricultural lands and its reclamation, steady state and transient designs of surface and sub-surface drainage systems, drainage by wells.	30 Hours	1

**References:**

1. Asawa G L, "Irrigation and Water Resources Engineering", New Age International Publishers, New Delhi.
2. Dan Yaron, "Salinity in irrigation and water resources", Marcel Dekker Inc. Newyork.
3. Michael A M, "Irrigation theory and practices", Vikas Publishing House, New Delhi.
4. Richard H Cuenca, "Irrigation system design – An Engineering Approach", Prentice Hall, Englewood Cliffs, New Jercey.
5. Dilip kumar Mujumdar, "Irrigation Water Management Principles and Practice", PHI Publication New Delhi.

## GE4 (UB) 13 HYDRO POWER STRUCTURES

### Course Objective:

1. To know about the energy sources for power generation.
2. To know about the basics of power potential studies.
3. To know about the classification and types of hydropower plant.
4. To know about the basics of power house planning.

### Learning Outcome:

1. Exposure on energy sources for power generation.
2. Illustrate about the basics of power potential studies.
3. Exposure on classification and types of hydropower plant.
4. Exposure on power house planning.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Introduction</b> Energy sources for power generation, Power scenarios, Demand and supply of power, need of hydro power, General Hydrology, Environment and Hydro Power Development.	30 Hours	1
II	Power potential studies: Estimation of available water power, Power duration curve, Storage and pondage, Load studies, Technical terms related to hydropower, System integrated operational studies, Load prediction, Installed capacity, Size and number of units.	30 Hours	1
III	<b>Classification and types of hydropower plant</b> Classifications, types, Storage power development ,components of storage power development, economic aspects, social and rehabilitation aspects, Run-Off-River power development, types of ROR, components of run-off-river power development, Run-of-power development on canal falls, Underground and pumped storage power plants , advantages, types and location of underground power station, its components, types of layout, limitations of underground power plants. Essential requirements of pumped storage power plant, economics of PSPP, Cost of power generated, Canal head power plant.	30 Hours	1
IV	<b>Power House Planning</b> General layout of the power house and arrangement of hydropower units, Number and sizes of units, space	30 Hours	



	allocation and dimensions, Super structure, Indoor, Semi-outdoor and Outdoor powerhouse, Lighting and Ventilation, Variation in design of power house, Safety requirements, Operation and maintenance of hydro plants.		
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**References:**

1. Barrows H. K., "Water Power Engineering", Mc Graw Hill Book Co., NewYork.
2. Dandekar and Sharma, "Water Power Engineering", Vikas Publishing House, New Delhi.
3. Deshmukh M.M., "Water Power Engineering", DhanpatRai Publications, New Delhi.
4. Nigam N C, "Handbook of hydro-power engineering", publishers Nem Chandand sons, Roorkee.
5. Sharma R.K. and Sharma T.K., "Water Power Engineering" S.CHAND &Company, New Delhi.
6. Varshney R.S, "Hydropower Structures", Nemchand and Bros., Roorkee.
7. Guthrie Brown, "Hydropower Electric Engineering", Blacki and Son, London.

## GE4 (UB) 14 COMPUTATIONAL FLUID DYNAMICS

### Course Objective:

1. To know about the basics complex analysis
2. To know about the numerical solution of system of equations.
3. To know about the Numerical Solution of ordinary differential equations and partial differential equations.
4. To know about the parabolic equations.

### Learning Outcome:

1. Exposure on complex analysis
2. Exposure on numerical solution of system of equations.
3. Exposure on numerical solution of ordinary differential equations and partial differential equations.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	<b>Complex Analysis</b> Analysis functions, Equipotential curves and streamlines and their orthogonality, complex potential, Potential flow, Singularities of potential functions and their types. Sources and sinks. Image system to form the complex potential. Doublets Complex integration, Laurentz Series, Residue Theorem and its applications.	30Hours	1
II	<b>Numerical Solution of system of equations</b> Nonlinear equations by Newton-Raphson and general iterative methods. Numerical solution of a system of differential equations by Runge-Kutta methods of order two and four.	30 Hours	1
III	Numerical Solution of ordinary differential equations and partial differential equations Solution of Boundary value problems by weighted residual methods: Collocation, Galerkin and Rayleigh-Ritz methods.	30 Hours	1
IV	<b>Parabolic equations</b> Schmidt and Crank-Nicholson Schemes, Elliptic equations: Five points scheme, Hyperbolic equations: Explicit and implicit schemes.	30 Hours	1

## References:

1. Anderson D. John, "Computational Fluid Dynamics", McGraw Hill Education.
2. Versteeg H., Malasekra W., "An Introduction to Computational Fluid Dynamics : The Finite Volume Method", Pearson India.
3. [Ferziger](#) J. H., "Computational Methods For Fluid Dynamics", Springer.
4. [Biswas](#) Gautam, "Computational Fluid Dynamics", Narosa Book Distributors Pvt Ltd.
5. [Niyogi](#) Pradip, "Introduction to Computational Fluid Dynamics", Pearson India.
6. [Wendt](#) F. John, "Computational Fluid Dynamics: An Introduction", Springer Publisher.

**GE4 (UB) 15 SOCIO-ECONOMIC AND ENVIRONMENTAL EVALUATION  
OF WATER RESOURCES PROJECTS**

**Course Objective:**

1. To know about the basics of water resources projects and socio-economic analysis.
2. To know about the basics of environment.
3. To know about the project proposal and implementation.
4. To know about the project evaluation.

**Learning Outcome:**

1. Exposure on water resources projects and socio-economic analysis.
2. Illustrate about the basics of environment.
3. Exposure on project proposal and implementation.

**Course Contents:**

<b>Module</b>	<b>Course Topics</b>	<b>Total Hours</b>	<b>Credits</b>
<b>I</b>	<p><b>Water Resources Projects</b> Need and importance of Water Resources Projects, Types of projects.</p> <p><b>Socio-Economic Analysis</b> Social and Economic evaluation of population, standards of living, Community needs, Socio-Economic objectives.</p>	30Hours	1
<b>II</b>	Ecosystems, Habitat assessment, Environmental objectives, study of available resources, Environmental monitoring, and Environmental evaluation techniques.	30 Hours	1
<b>III</b>	Principles of economic planning and decision making, price theory and resource allocation Project Optimality conditions, cost- benefit studies: role of benefit-cost parameter in project selection. Economic feasibility tests. Involvement of risk and other variables, tangible and intangible benefits; Cost-benefit studies of single and multipurpose water resources projects	30 Hours	1
<b>IV</b>	<p><b>Project Evaluation</b> Evaluation and impact of projects like irrigation, Power Supply, Water Supply, Flood Control, Sewage, etc. Facilities generated, negative effects-inundation, migration, etc. Economic planning: Capacity expansion and project scheduling, multi-objective planning models</p>	30 Hours	1

**References:-**

1. Modi P.A., "Economic development and Environmental Issues"
2. Abbasi S.A., "Water Resources Projects and their Environmental Impacts",  
Discovery Publishing Pvt.Ltd.

## GE4 (UB) 21WATER SUPPLY DISTRIBUTION SYSTEMS

### Course Objective:

4. To know about the basics of distribution system
5. To know about the basics of distribution reservoir
6. To detect the leakage in distribution pipes and design of distribution networks
7. To know about appurtenances in the distribution system.

### Learning Outcome:

1. Exposure of distribution system, layouts and method of distribution
2. Exposure of distribution reservoirs, storage capacity of the reservoirs
3. Exposure to fixing the sizes of pipes and analysis of complex pipe network
4. Exposure of the appurtenances used in distribution system.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Requirements of good distribution system. Arrangement of distribution pipes and other accessories. Layout of distribution networks, methods of distribution, pressure in the distribution system, system of supply.	30 Hours	1
II	Functions of distribution reservoirs, types of distribution reservoirs, stand pipes, storage capacity, location and height of the distribution reservoirs.	30 Hours	1
III	Detection of leakage in the distribution pipes, fixing the sizes of pipes, Methods of analysis, Hardy – Cross method, Newton Raphson method and Linear theory method.	30 Hours	
IV	Fire hydrants, requirements of good fire hydrant, water meters, requirements and types of good water meter, pipe fittings	30 Hours	1

### References:-

1. Bhave P R, “Analysis of Flow in Water Distribution Network”, Technomic Publishing Co., Lancaster, USA.
2. Bhave P R, “Optimal Design of Water Distribution Networks”, Narosa Publishing house, New Delhi.
3. Streter V L and Wylie E D, “Fluid Transients”, McGraw Hill Book Co.
4. Pramod R. Bhave and Rajesh Gupta, “Analysis of Water Distribution Networks”, Published by Narosa Publishing House, New Delhi and Alpha-Science Publication,UK.
5. S K Garg, “Water Supply Engineering”, Khanna Publishers

## GE4 (UB) 22 ENVIRONMENTAL ASPECTS OF WATER RESOURCES

### Course Objective:

1. To know about the basics of Ecology and its development.
2. To know about the basics of hydrological cycle.
3. To know about the basics of Ecological impacts and methods of EIA.
4. To know about the basics of Human Ecology.

### Learning Outcome:

1. Exposure on Ecology and its development.
2. Illustrate about the basics of hydrological cycle.
3. Illustrate about the basics of Ecological impacts and methods of EIA.
4. Exposure on Human Ecology.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Ecological principles, Levels of organization, Aquatic Ecology, Hydrobiology, Concept of ecosystems, Energy flow in aquatic ecosystems, Biogeochemical cycles, Population and community organization, Concepts of carrying capacity, Biological diversity, Ecosystem development.	30 Hours	1
II	Suspended and dissolved solids in water, Sources of pollution, Water quality classification, Impacts on hydrological cycle, Eutrophication, Bio-magnifications, Water quality indices, Transformation and fate of pollutants, Role of sediments in water quality.	30 Hours	1
III	Environment in water resources projects, Environmental requirements and laws, Environmental impacts: hydrological, social, biological and water quality, Methods of EIA, Base line survey, EIA statements, Ecological impacts, Habitat evaluation.	30 Hours	1
IV	Human Ecology, Large vs small dams, in stream ecological needs, Deforestation, watershed and water quality changes, Ecosystem services, Environmental data bases and networks, Ecological monitoring programs, Environmental quality indices, Sustainable water resources development.	30 Hours	1

**References:-**

1. Canter L. W, "Environmental Impact Assessment", McGraw Hill International Editions, 2nd edition, New York.
2. Mc Cully P, "Silenced Rivers, The ecology and politics of large dams", Orient Longman India.
3. Odum E. P., "Basic Ecology, 13th Edition", Saunders and Co., Philadelphia.
4. Odum H. T., "Systems Ecology, 3rd edition", Saunders and Co., Philadelphia.
5. Schmitz R. J., "Introduction to water pollution biology", Gulf Publishing Co., Texas.



## GE4 (UB) 23 COMPUTATIONAL TECHNIQUES IN WATER RESOURCES ENGINEERING

### Course Objective:

1. To know about the basics computational Techniques in Water Resources Engineering.
2. To know about the basics of Statistical Techniques.
3. To know about the basics of Numerical Methods.
4. To know about the basics of Hydro informatics and its applications.

### Learning Outcome:

1. Exposure on computational Techniques in Water Resources Engineering.
2. Illustrate about the basics of Statistical Techniques in WRE.
3. Illustrate about the basics of Numerical Methods in WRE.
4. Exposure on Hydro informatics and its applications.

### Course Contents:

Module	Course Topics	Total Hours	Credits
<b>I</b>	Introduction: Introduction to computational Techniques, Database design, Spreadsheet, Usefulness in Water Resources Engineering.	30 Hours	1
<b>II</b>	Statistical Techniques: Presentation of data, Measures of location and dispersion, Probability concepts and distribution, Tests of significance, Correlation and Regression, Selection of Suitable technique, error analysis.	30 Hours	1
<b>III</b>	Numerical Methods: Finite difference schemes, Method of characteristics, Finite element method Advanced Techniques Genetic algorithm, Artificial Neural Network, Fuzzy logic, Other data driven methods.	30 Hours	1
<b>IV</b>	Hydro informatics: Introduction, Virtual institute, Web based hydro informatics system. Applications: Application with case studies, Selection of suitable technique, Different types of hydraulic engineering software, Salient features, Capabilities and Limitations.	30 Hours	1

## References:-

1. Abbott M.B., “Hydroinformatics – Information Technology and the Aquatic Environment”, Avebury Technical, Aldershot.
2. Adeli H. and Hung S., “Machine Learning – Neural Networks, Genetic Algorithms and Fuzzy Systems”, John Wiley, New York.
3. Chaudhry M.H., “Open Channel Flow”, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi.
5. Govindaraju, R. S. and Rao, A. R. (eds.). “Artificial Neural Networks in Hydrology”, Kluwer Academic Publishers, Dordrecht.
6. Rajsekaron S. and VijayalakshmiPai G.A., “Neural Networks, Fuzzy Logic and Genetic Algorithms-Synthesis and Applications”, PHI Learning Pvt. Ltd., New Delhi.

## GE4 (UB) 24 REMOTE SENSING APPLICATIONS IN WATER RESOURCES ENGINEERING

### Course Objective:

1. To know the basics of Principles of GIS, GPS and Remote Sensing.
2. To know about the data products, Interpretation and Analysis Techniques.
3. To know about the data processing.
4. To know about the disaster management.

### Learning Outcome:

1. Exposure on Principles of GIS, GPS and Remote Sensing.
2. Illustrate about the data products, Interpretation and Analysis Techniques.
3. Exposure on data processing.
4. Exposure on disaster management.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Principles of GIS, GPS and Remote Sensing: Basic concepts of GIS & GPS, introduction to remote sensing, remote sensing system, electromagnetic spectrum, black body, atmospheric windows, spectral characteristics of earth's surface, range of sensing system, Components of GPS, factors affecting, GPS setup, accessories, segments, satellites & receivers, GPS applications.	30 Hours	1
II	Platforms, Sensors and Data Products: Ground aircraft, Spacecraft platforms, photographic sensors, scanners, radiometers, radar and mission planning, data types and format, scale and legend. Interpretation and Analysis Techniques: Multispectral, multitemporal, multisensoral, multistage concepts, photo interpretation techniques for aerial photo and satellite imagery, interpretation elements, false colour composition.	30 Hours	1
III	Structure of GIS: Cartography, Geographic mapping process, transformations, map projections, Geographic Data Representation, Storage, Quality and Standards, database management systems, Raster data representation, Vector data representation, Assessment of data quality, Managing data errors, Geographic data standards. GIS Data Processing, Analysis and Modeling: Raster based GIS data	30 Hours	1

	processing, Vector based GIS data processing, Queries, Spatial analysis, Descriptive statistics, Spatial autocorrelation, Quadrant counts, and nearest neighbour analysis, Network analysis, Surface modeling, DTM.		
<b>IV</b>	Application in Civil Engineering: River drainage and flood flow, watershed delineation and characteristic studies, command area mapping, drought assessment, groundwater inventory, soil moisture study, water quality assessment and monitoring, Land use data acquisition, disaster management.	30 Hours	1

**References:**

1. Thomas, M. Lillisandand KieferR.W., "Remote Sensing and Image Interpretation", JohnWiley.
2. Sabins and Floyd, F.J.R, "Remote Sensing Principles and Interpretation", W.H. Freeman, Sanfrancisco.
3. Elachi C., "Introduction to Physics and Techniques of Remote Sensing", New YorkWiley.
4. Phillip, H. Swain and Shirley, M. Davis,"Remote Sensing-The Quantitative Approach",McGraw Hill Publications.
5. Johnson, R. Jenson,"Introductory Digital Image Processing", Prentice hall.
6. Agarwal, N. K., "Essentials of GPS, Spatial Networks Pvt. Ltd., Hyderabad.

## GE4 (UB) 25 FINITE ELEMENT ANALYSIS

### Course Objective:

1. To know the basics concept of FEM.
2. To know about the basics of one dimensional Finite Elements.
3. To know about the basics of two and three dimensional Finite Elements.
4. To know about the natural coordinate system.

### Learning Outcome:

1. Exposure on concept of FEM.
2. Exposure on one dimensional Finite Elements.
3. Exposure on two and three dimensional Finite Elements.
4. Exposure on natural coordinate system.

### Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction to Finite Element Method, Brief History of the Development, Advantages & Disadvantages of Finite Element Method, The Displacement Approach. Foundations of the FEM-Energy Principles.	30 Hours	1
II	One Dimensional Finite Elements, Stiffness Matrix for the basic Bar & Beam Element Representation of Distributed Loading, The Assembly Process within the PMPE Approach, Element Stresses. Shape Functions & Interpolation Polynomials.	30 Hours	1
III	Finite Elements for Two Dimensional Planar Bodies. Triangular Elements for Plane Stress or Strain Conditions. Higher Order Triangular Elements. Rectangular Elements for Plane Stress or Strain Conditions. Finite Elements for Three Dimensional Analysis, Tetrahedral Elements. Higher-Order Tetrahedra. Rectangular Hexahedral Elements. Higher-Order Rectangular Hexehedra.	30 Hours	1
IV	Advanced Concepts In The Formulation of Two & Three Dimensional Elasticity Elements. Natural Co-ordinates. Area or Triangular Co-ordinates. Serendipity Rectangles & Hexahedra. The Isoparametric Concept. Properties of Isoparametric Elements. Numerical Integration.	30 Hours	1

**References:-**

1. Cook, R.D., Malkus, D.S. and Plesh, M.E.”Concepts and Applications of Finite Element Analysis”, John Wiley & Sons Inc. New York.
2. Bathe, K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall.
3. Reddy, J.N., “An Introduction to Finite Element Method”, McGraw Hill.
4. Dawe, D.J., “Matrix and Finite Element Displacement Analysis of Structures”, Clarinton Press, Oxford.